

IOANNA COLE & BRUCE DEGEN

The Magic School Bus

and the Science Fair Expedition



What is science?

Ms. Frizzle's students need science fair projects and they need them fast! As usual, Ms. Frizzle has a zany plan. The class heads out for a whirlwind tour of science through the ages, getting ideas from some of the greatest scientists of all time — Galileo, Newton, Einstein, and more.

The scientists they meet are inquisitive, creative, and determined — a lot like Ms. Frizzle! After all, with their observations, experiments, and endless curiosity, these brilliant minds laid the foundation for modern science — and for our science fairs today. So don't miss the bus. Hop aboard for an illuminating look at what science is all about!

Jacket art © 2006 by Bruce Degen


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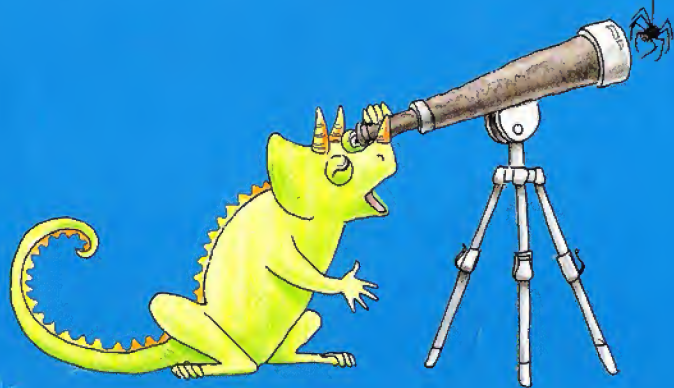
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OUR FAVORITE SCIENTISTS

GEORGE WASHINGTON
CARYER
Agricultural Research



STEPHEN W. HAWKING
Origins of the Universe



GREGOR MENDEL
Laws of Heredity



THAT'S NOT A
REAL
SCIENTIST!

BUT HE'S
FAMOUS!

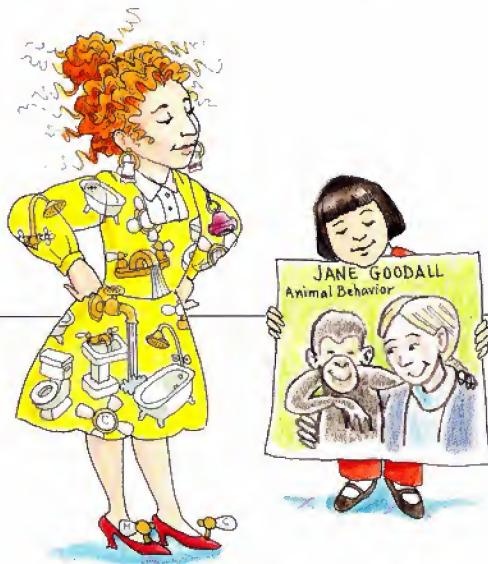


The Magic School Bus

and the Science Fair Expedition

By Joanna Cole

Illustrated by Bruce Degen



Scholastic Press / New York

Many people have helped in the making of this book. Our gratitude goes to John and Mary Gribbin, for their expert review and wonderfully informed perspective. And to Robin Wasserman, for her keen observations. Thanks to John Helms for his expertise — and for weighing the paper clip! To Warren Hirsch and Steven Vizner for astronomy and radium know-how. To Rachel Cole, Heidi Coffin, Mark Goldman, Erica Goldman, and Chris Santoro for their reading and comments. And to Michael Proia on Peaks Island, Maine, for tweaking Arnold's speech bubble on page 28. Appreciation also goes to our editors Kristin Earhart, and especially Craig Walker, who has been inspiring us from the very start. To Stephanie Calmenson for her wise counsel and pertinent questions. And, always, to our spouses Phil Cole and Chris Degen for their enduring support.

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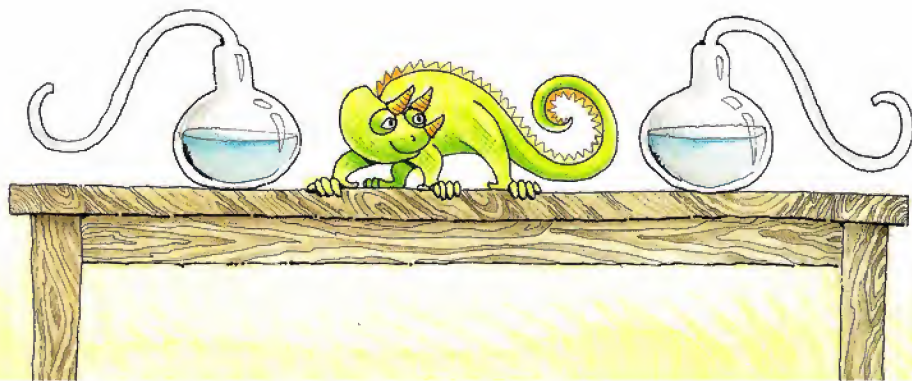
Printed in Singapore 46

First edition, August 2006

The text type was set in 15-point Bookman Light.
The illustrator used pen and ink, watercolor, color pencil,
and gouache for the paintings in this book.

To Stephanie Calmenson,
for her generosity, humor, and advice,
but most of all, for her friendship,
which has so enriched my life.
—J.C.

To my dear family,
at home and abroad,
with the world in their hands,
and the earth between their fingers.
—B.D.



In Ms. Frizzle's class, we really needed help!
We were working on projects for the science fair.
The fair was only a few days away,
but some of us had no idea what to do.





Then Arnold had a suggestion:
"We could get ideas at the new science museum."
The museum was just around the corner.
We could walk there instead of riding
on our wacky old school bus!



BYE-BYE, BUS!

WITHOUT THAT CRAZY BUS,
MS. FRIZZLE CAN'T TAKE US
ON A CRAZY TRIP.

WALK THIS WAY,
CHILDREN.



Ms. Frizzle led the way through the museum doors. Inside, there were so many things to see and do.

CLASS, THIS SAYS THAT SCIENCE IS ABOUT TESTING IDEAS.

DID SHE SAY WE'RE HAVING A TEST?

RIGHT HERE IN THE MUSEUM?

NOT TO WORRY. SHE'S JUST TALKING, I HOPE.

WITHOUT THE SCIENTIFIC METHOD

Get an idea → Don't test it →
→ Believe what you want.

Idea:
AIR HAS WEIGHT

WE DON'T FEEL ANY WEIGHT.

WE DON'T BELIEVE IT.

I DO.

WHO IS RIGHT?

WE CAN'T TELL.

WITH THE SCIENTIFIC METHOD

Get an idea →
Test it before believing it.

Idea:
AIR HAS WEIGHT

LET'S TEST IT.

Weigh a bottle that has air in it.

Pump the air out.

Weigh the bottle again.
It weighs less.

SO THE AIR DOES HAVE WEIGHT.

WE PROVED IT!

COMING HERE WAS A
GREAT IDEA, ARNOLD!

I COULD DO A PROJECT
ON MAGNETS.

I COULD DO ONE ON
BRIDGES.

BIOSPHERE

MAGNETIC CHARGE

OPPOSITES ATTRACT

LIKES REPEL

ARCHES

BUT MS. FRIZZLE, WE STILL
DON'T HAVE A PROJECT.

COMPLETING A CIRCUIT

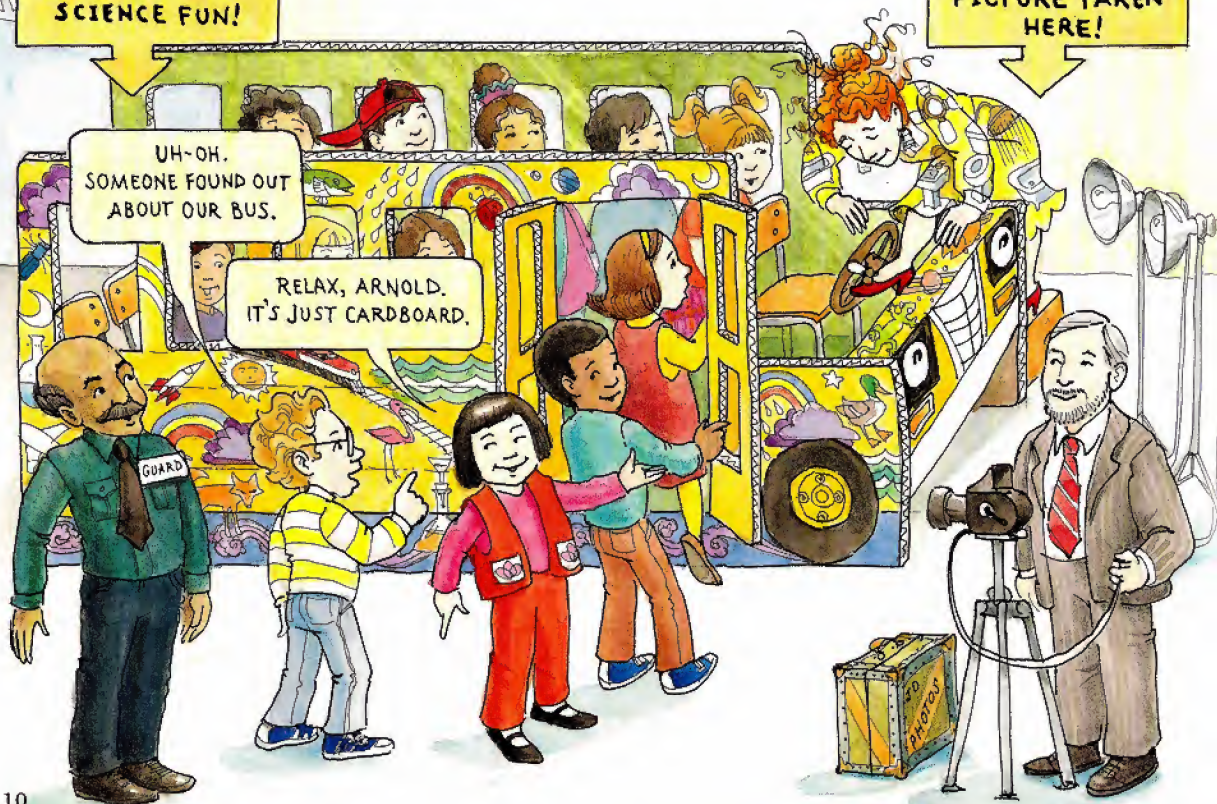
Then we saw a big cardboard bus.
We could get our picture taken on it.
We all climbed aboard.

RIDE THE BUS
THAT MAKES
SCIENCE FUN!

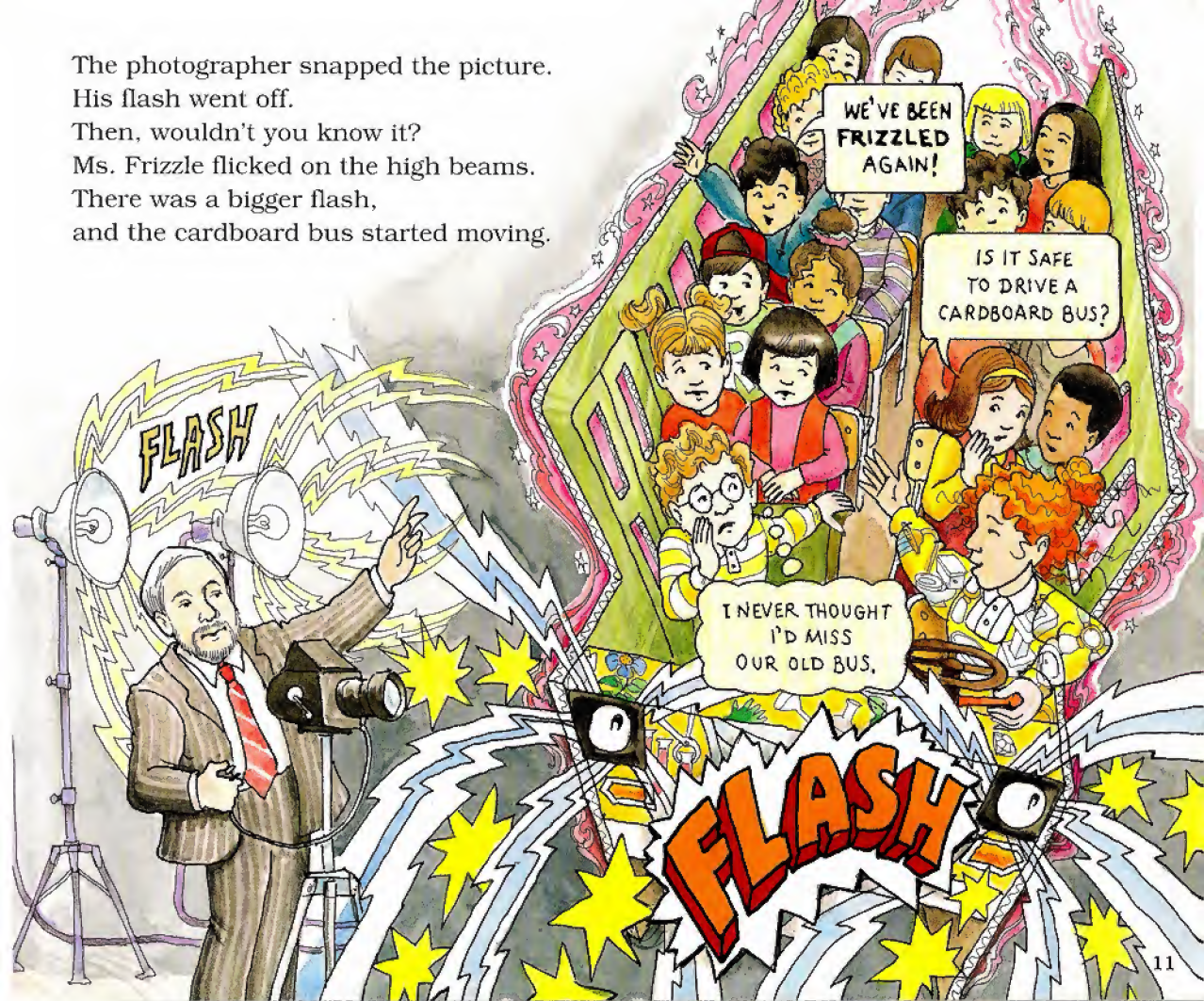
GET YOUR
PICTURE TAKEN
HERE!

UH-OH.
SOMEONE FOUND OUT
ABOUT OUR BUS.

RELAX, ARNOLD.
IT'S JUST CARDBOARD.



The photographer snapped the picture.
His flash went off.
Then, wouldn't you know it?
Ms. Frizzle flicked on the high beams.
There was a bigger flash,
and the cardboard bus started moving.



We rolled up to a wide entryway that led to a show on great scientists.

"Isn't this wonderful, children?" said Ms. Frizzle.

"We're going to learn how scientists work!"

GREAT SCIENTISTS THROUGH THE AGES

WEATHER: FOLLOW EL NIÑO

HOW CAN OCEAN TEMPERATURES START HURRICANES?

VOLCANO! MOUNT VINEGAR



WHAT HAPPENS WHEN YOU ADD VINEGAR TO BAKING SODA?

SCIENCE Q&A by Carlos

Q. What's the first thing you need to be a Scientist?

A. CURIOSITY!

Science began because people asked questions about the world.

HOW? WHAT? WHAT IF...?



I JUST KNOW THIS WILL HELP WITH OUR SCIENCE PROJECTS!

I'M GETTING A BAD FEELING ABOUT THIS.

DOESN'T SHE NOTICE THAT THIS BUS IS WEIRD?

IT'S EVEN WEIRDER THAN OUR REAL BUS!

Inside, we saw life-size models of famous scientists in history. Our bus glided past a model of Copernicus. "This famous scientist said that the planets – including our Earth – went around the sun," said Ms. Frizzle. "But he could not prove it."

IN THE TIME OF COPERNICUS, MOST PEOPLE THOUGHT THE EARTH WAS THE CENTER AND THE SUN WENT AROUND IT.

TODAY WE KNOW THE SUN IS AT THE CENTER.

I THOUGHT I WAS THE CENTER OF EVERYTHING.

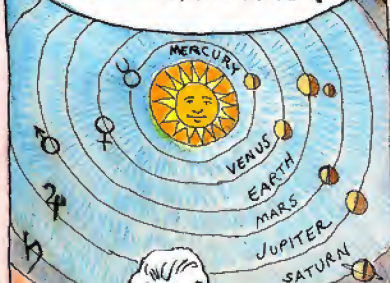
WE NOTICED THAT.

EXHIBIT: PART ONE
The Sun and the Planets



**GALILEO'S
QUESTION:**

**HOW CAN I PROVE
THAT THE EARTH MOVES?**



GALILEO GALILEI
Born 1564
Died 1642

As the bus came up to the model of Galileo, we got a big surprise. The model came to life! Galileo ran over, knocked on the door, and shouted, "I'm about to make an important discovery! I need my telescope! I need a ride home!"

MY BOOK SAYS NEVER TO
PICK UP HITCHHIKERS...

...UNLESS THEY ARE FAMOUS
DEAD SCIENTISTS.



The Friz opened the bus door, and Galileo hopped on. "You're in luck, Gal," said Ms. Frizzle. "We were just leaving." There was a blinding flash, and the bus jerked forward. "Next stop, Italy, four hundred years ago," shouted the Friz from the driver's seat.



A STORY ABOUT GALILEO

He Made a Better One

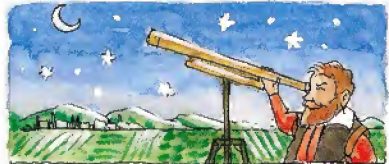
In the early 1600s, people in Italy had never seen a telescope. Then Galileo heard that a man had brought one to his country.



Galileo wanted to look through the telescope, but it was in another part of Italy. So he made one of his own.



Other people had used telescopes to look at ships or armies. Galileo did what no one had done before. He used his to look at the night sky.



The next thing we knew,
the bus had rolled up in front
of a tall, narrow house.
Galileo went in and came out
with a telescope.



Almost seventy years had passed since Copernicus's death, but many people still didn't believe his idea that the Earth went around the sun.

"I think Copernicus was right!" said Galileo.

WE THINK COPERNICUS WAS WRONG.

THE EARTH CAN'T TRAVEL.

IF IT DID, THE MOON AND THE EARTH WOULD DRIFT APART!

I'LL FIND EVIDENCE THAT THE EARTH MOVES.

A WORD FROM DOROTHY ANN
EVIDENCE is something that can help prove an idea.

I BELIEVE THERE IS AN ELEPHANT IN THE BATHTUB.

EVIDENCE

GO FOR IT, GALILEO!



PLANETS ARE MOVERS

- by Phoebe
- People knew that Jupiter and other planets move. For thousands of years they had seen them moving slowly across the sky.



Since Galileo's time, more of Jupiter's moons have been seen. Today there are more than sixty!

"I have to show that the Earth can move," said Galileo. That night, he looked at the sky through his telescope. We got a chance to look, too. We saw a big planet with four moons around it. The planet was Jupiter.

I AM THE FIRST PERSON IN THE WORLD TO SEE MOONS GOING AROUND A PLANET!

I'M THE SECOND!

I'M THE THIRD!

I'M GOING TO BE THE 20TH.

Galileo thought hard about his evidence. Ms. Frizzle told us, "Galileo's discovery was important, class. It showed that our Earth and moon could move together around the sun."

HOW SCIENTISTS WORK

by Keesha

- They observe nature.
(Galileo looked at Jupiter.)
- They gather evidence.
(Galileo saw that Jupiter moved and it had moons)
- They use logical thinking.
(Galileo connected the facts he had learned.)

WE HAVE SEEN JUPITER MOVE

AND WE HAVE SEEN ITS MOONS.

THE PLANET AND THE MOONS MOVE TOGETHER.

THAT MEANS OUR EARTH AND MOON CAN MOVE TOGETHER, TOO!

THANK YOU, GALILEO. NOW WE HAVE TO GET MOVING, OURSELVES.

GALILEO IS OFTEN CALLED THE WORLD'S FIRST MODERN SCIENTIST.

JUPITER AND ITS MOONS

EARTH MOON
SUN

As we were driving away, we met someone standing in the road and staring into space. It was not the kind of staring into space Galileo did with his telescope. It was the kind that gets you run over by a cardboard bus. The man was Isaac Newton.

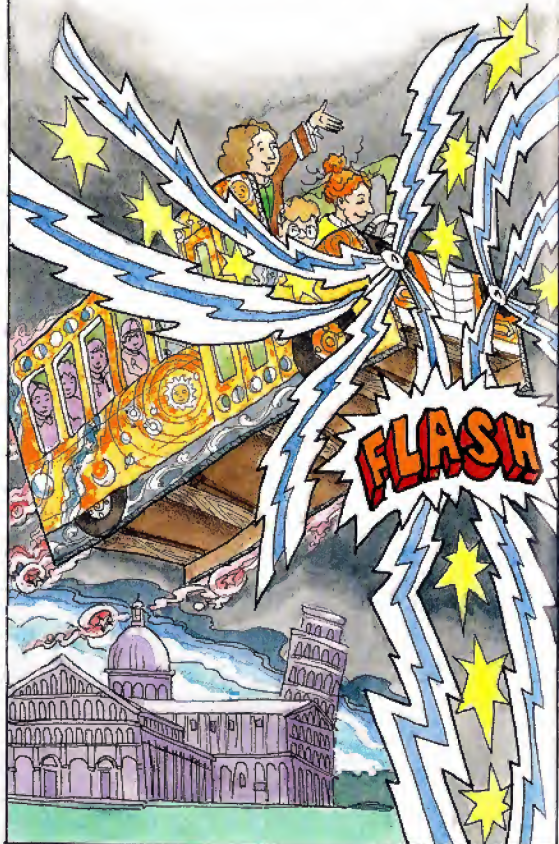
MS. FRIZZLE, WATCH OUT FOR THAT MAN!

ISAAC NEWTON, YOU ARE IN THE WRONG TIME AND PLACE.

LET'S TAKE HIM HOME.

Sir Isaac Newton
Born 1642
Died 1727

Newton climbed aboard.
Ms. Frizzle flicked on her brights
and . . . *FLASH!* The bus took off!



In an instant, we were on a farm in England.
Just like that, it was fifty-five years later.
Newton stepped off the bus
and sat under an apple tree.

NEWTON'S QUESTION:
WHAT KEEPS THE PLANETS
IN THEIR ORBITS?

HE'S JUST
SITTING THERE.

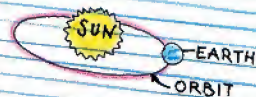
IF HE'S SUCH A BIG SHOT
SCIENTIST, SHOULDN'T HE BE
DOING AN EXPERIMENT?

DON'T WORRY, CLASS.
HE'S THINKING.

SON, DON'T LET THOSE
COWS WANDER OFF.

ANOTHER WORD
FROM DOROTHY ANN

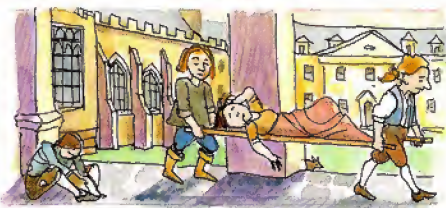
An orbit is the path of
an object-like the Earth-
around another object-
like the sun.



A STORY ABOUT NEWTON

Home from College

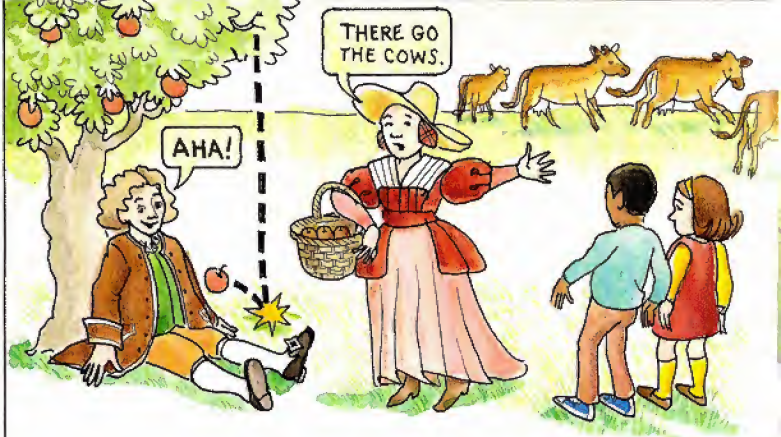
In 1665, while Newton was studying at Cambridge University, a terrible disease called the plague broke out.



The university sent all the students home, so they wouldn't get sick. Newton returned to his family farm.



While at home, he discovered many things. The most important was that the laws of motion on Earth are the same laws that control the motion of the whole universe. This idea is called Newton's Law of Universal Gravitation.



Ms. Frizzle said Isaac was thinking about the Earth and the moon.

Thump! Isaac saw an apple fall off the tree.

"Hmm," he said. "I know that the apple was pulled by Earth's gravity.

If gravity's pull can reach to the top of the tree, maybe it can reach as far as the moon."

THAT'S JUST SILLY!

THE PLANETS AND MOONS ARE NOT LIKE APPLES!

WHAT HAPPENS IN THE SKY HAS NOTHING TO DO WITH WHAT HAPPENS ON EARTH!



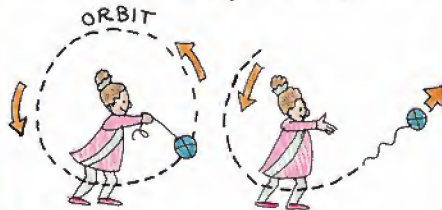
Now Newton began thinking about the sun and planets. He told us, "The sun's gravity holds the planets and their moons in orbit."

HOW GRAVITY MAKES ORBITS

by Keesha

Keesha is like the Earth.
The string is like gravity.
The ball is like the moon.

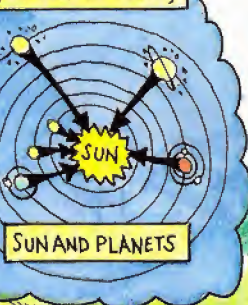
WHIRL THE BALL (moon)
ON THE STRING (gravity). THEN LET IT GO!



WITHOUT "GRAVITY,"
THE "MOON" FLIES AWAY.

GRAVITY IS
THE "GLUE"
THAT HOLDS
THE UNIVERSE
TOGETHER!

NEWTON'S THOUGHTS:
(Lots of ideas, No cows.)



WE'D BETTER CATCH
THOSE COWS.

NEWTON IS SUPPOSED
TO BE WATCHING THEM.

HE CAN'T -
HE'S THINKING
TOO HARD.

MORE ON HOW

SCIENTISTS WORK by Tim

They often prove things
by describing them
mathematically.

- 0 (Newton did his math homework.)



NEWTON

GALILEO

COPERNICUS

NEWTON BUILT
ON THE WORK
OF OTHERS.

Newton wanted to prove his ideas.
He was able to do that using math.
Math is the language that scientists
use to describe the universe.

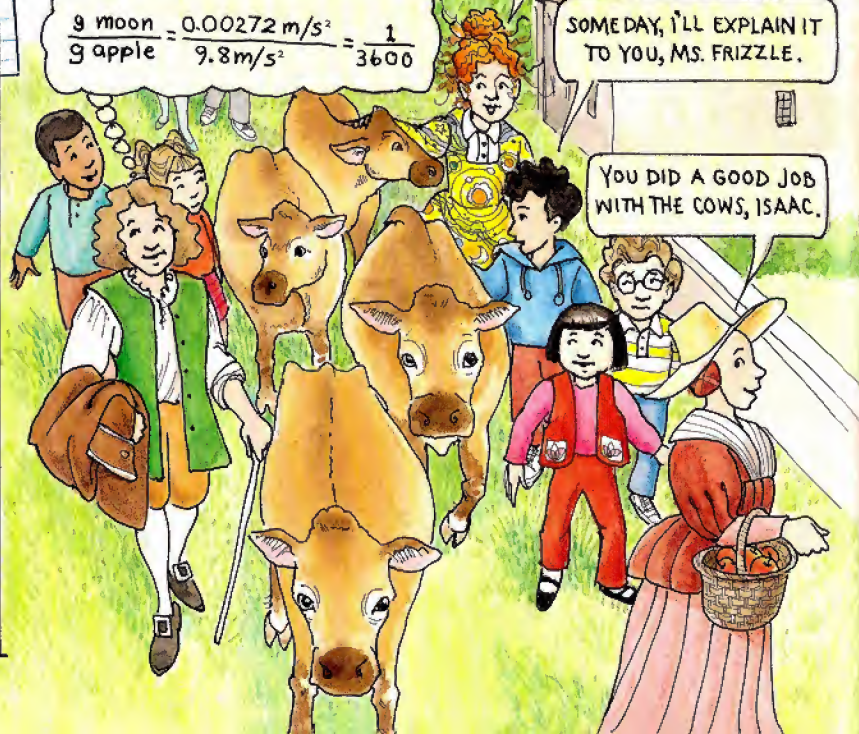
NEWTON'S LAW OF
UNIVERSAL GRAVITATION

$$\frac{g_{\text{moon}}}{g_{\text{apple}}} = \frac{0.00272 \text{ m/s}^2}{9.8 \text{ m/s}^2} = \frac{1}{3600}$$

CLASS, NEWTON'S MATH
IS VERY ADVANCED.

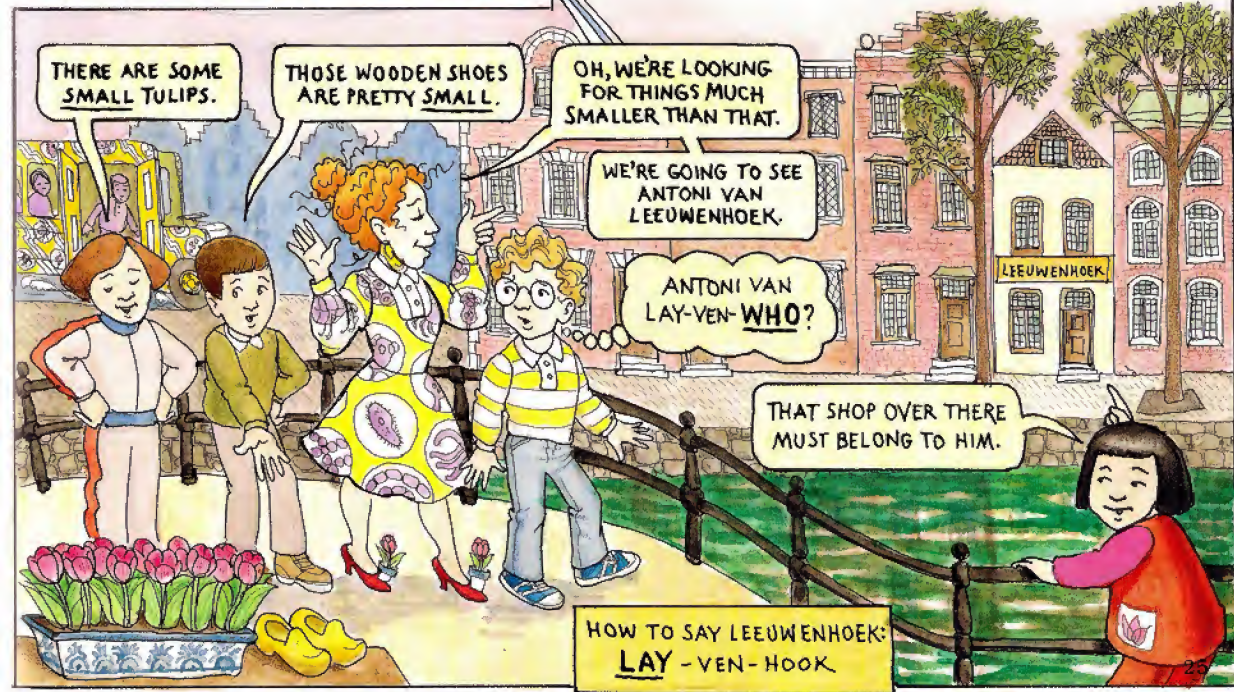
SOMEDAY, I'LL EXPLAIN IT
TO YOU, MS. FRIZZLE.

YOU DID A GOOD JOB
WITH THE COWS, ISAAC.





We thanked Newton and piled into the bus. Ms. Frizzle called from the driver's seat, "Copernicus, Galileo, and Newton studied something very big – the universe! Let's meet scientists who study *small* things." She flicked her brights. In a flash, we were in Holland!



A STORY ABOUT ANTONI VAN LEEUWENHOEK

Looking at Threads

Antoni van Leeuwenhoek was a draper — a seller of cloth. But he was interested in a lot more than cloth. One day he saw a book by an English scientist named Robert Hooke. There were drawings of things Hooke had seen under a microscope. Antoni was amazed.



Antoni knew about magnifiers. Every day he used a magnifying glass to make sure the threads in his cloth were straight and tight. He decided to build his own microscope.



We went into Leeuwenhoek's cloth shop. There he was at the window, peering into an odd little microscope.



LEEUVENHOEK'S MICROSCOPE DOESN'T LOOK LIKE THE ONES WE USUALLY SEE.

HIS HAIRSTYLE DOESN'T LOOK LIKE THE ONES WE USUALLY SEE, EITHER.

IN LEEUVENHOEK'S DAY, MEN WORE WIGS, ARNOLD.

ANTONI VAN LEEUVENHOEK
Born 1632–Died 1723

Leeuwenhoek's microscope was so good that he saw things no one else could see.



LEEUEWENHOEK'S QUESTION:



ARE THERE LIVING THINGS SO TINY THAT WE CAN'T SEE THEM WITH JUST OUR EYES?

I'M LOOKING AT A DROP OF WATER. I CAN SEE LITTLE ANIMALS SWIMMING ALL AROUND.

LEEUEWENHOEK WAS THE FIRST TO SEE THESE TINY LIVING THINGS.

WHY IS THAT IMPORTANT?

BECAUSE AFTER LEEUEWENHOEK A WHOLE NEW SCIENCE WAS STARTED. IT WAS CALLED MICROBIOLOGY.

ONE MORE WORD FROM DOROTHY ANN

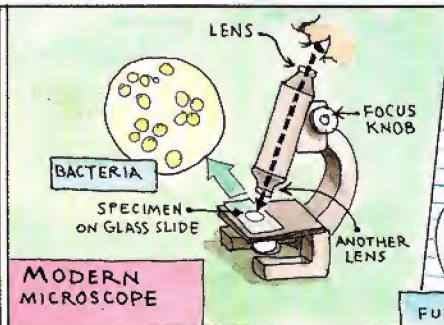
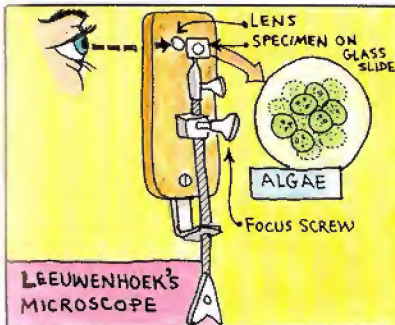
Microbiology is the science of tiny animals and plants.

LEEUEWENHOEK IS CALLED THE FATHER OF MICROBIOLOGY.

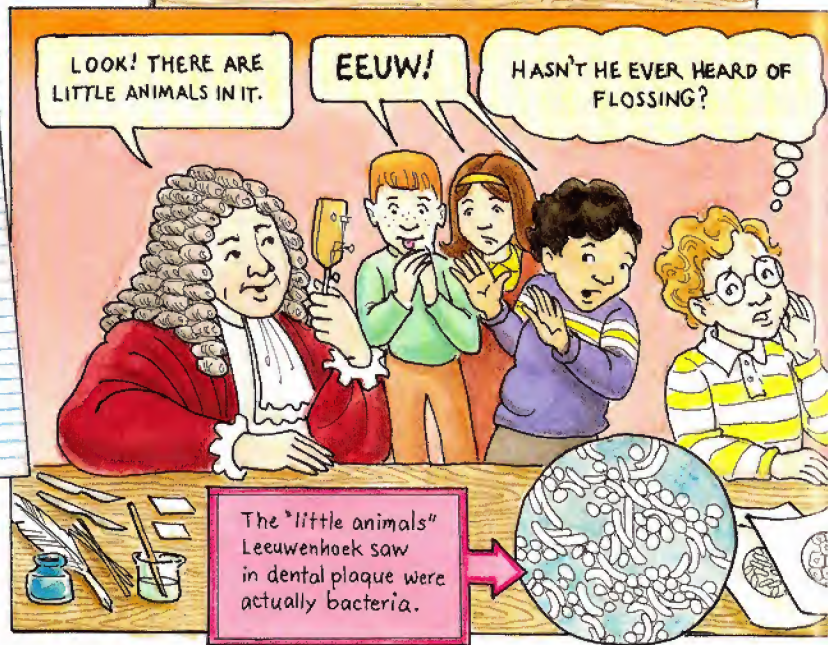
HE'S OUR DAD!

FUNGI

BACTERIA



"I've spent fifty years looking at things," said Leeuwenhoek.
"I'm curious about everything."
When he said "everything,"
he really meant it.
It could get kind of gross.

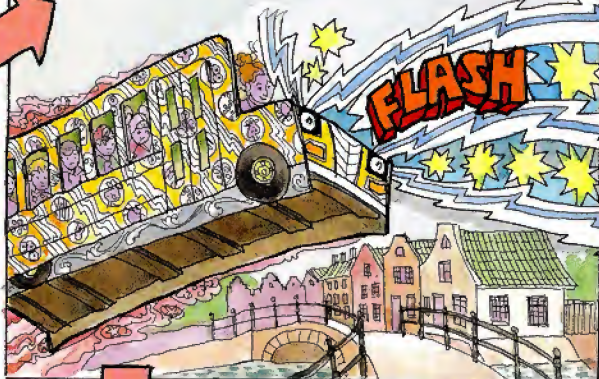


"We're out of here!" we yelled,
and we raced to the bus.

THANK YOU, ANTONI VAN LEEUWENHOEK!
YOU SHOWED US A WORLD OF TINY
THINGS ALL AROUND US AND IN US.

THANK YOU, MS. FRIZZLE.
YOU HELPED US ESCAPE
FROM THAT TINY AND
DISGUSTING WORLD.

Ms. Frizzle flashed the brights . . .



. . . and we landed in France . . . **HARD!**

HOW CAN A CARDBOARD
BUS GET A FLAT TIRE?

IS THERE A
CARDBOARD
SPARE?

BAM!

A STORY ABOUT LOUIS PASTEUR

Using Science for Health

Louis grew up in a small French town. He was very good in school, went to the best college in France, and became a scientist.



Soon people began to come to him with problems. Winemakers said, "My wine is going bad." Farmers had sick chickens, cows, and sheep. Louis wanted to help them all.



He began asking questions about all the problems. In his lab he found answers that helped make the world a healthier place.

Suddenly, a distinguished gentleman came by. "May I be of help?" he asked. "Louis Pasteur!" our teacher answered. "I was hoping you'd come along." When the tire was fixed, Louis asked us to drive him home.



CLASS, MEET
LOUIS PASTEUR.
HE MADE MODERN
MEDICINE POSSIBLE.

HE'S MAKING
CARDBOARD-BUS
TRAVEL POSSIBLE!

WHAT AN
AMAZING
VEHICLE!

LOUIS PASTEUR
Born 1822 - Died 1895

We all got on the bus, and Ms. Frizzle drove us into farm country. It was beautiful, but many of the farm animals were sick and dying.

"These animals have a terrible disease called anthrax," Pasteur explained. "I am going to work on it. Please take me to my laboratory in Paris."

ABOUT 200 YEARS HAVE PASSED SINCE LEEUWENHOEK FIRST LOOKED AT BACTERIA.

LEEUWENHOEK SAW BACTERIA. BUT HE DIDN'T THINK THEY CAUSED SICKNESS.

I THINK THEY CAN, AND I WANT TO PROVE IT.

TO THE LAB!

CLASS, ISN'T IT WONDERFUL HOW SCIENTIFIC KNOWLEDGE GROWS OVER THE YEARS?

PASTEUR'S QUESTION:

WHAT MAKES US SICK?

WHAT ARE BACTERIA?
by Shirley

Bacteria are tiny, one-celled living things. Some cause disease, but most are helpful.

WE CAUSE FOOD POISONING.

Salmonella enteritidis

WE HELP MAKE CHEESE.

Lactobacilli

ANOTHER WORD FROM

DOROTHY ANN

A hypothesis is an idea that will be tested by an experiment.

OUR EXPERIMENT SHOWS THAT BLOOD FROM AN ANIMAL WITH ANTHRAX CAUSES ANTHRAX.

HERE IS MY HYPOTHESIS: THE BACTERIA IN THE BLOOD IS WHAT CAUSES ANTHRAX.

I FEEL AN EXPERIMENT COMING ON!

In his lab, Pasteur explained, "People don't know what causes anthrax. They do know that if they take blood from a sick animal and inject it into a healthy one, the healthy animal will always get anthrax."

Some other Scientists

EXPERIMENT: OTHER SCIENTISTS INJECTED BLOOD

WE GOT BLOOD FROM A SICK ANIMAL.

WE INJECTED IT INTO A HEALTHY ANIMAL.

THE HEALTHY ANIMAL GOT SICK.

WE DECIDED THE BLOOD CAUSES THE DISEASE.

Blood from cow sick with anthrax

blood cells
bacteria

I AM SICK.

Pasteur carried out a great experiment.
It proved that the bacteria caused anthrax.
Once he knew that, he was able to make
a vaccine that prevented the disease.



HOW SCIENTISTS WORK by Arnold

They do experiments.
(Pasteur's experiments
saved lives.)

WITHOUT A DOUBT,
MY EXPERIMENT PROVES
MY HYPOTHESIS!

WHY IS THAT
IMPORTANT?

BECAUSE IF PEOPLE KNOW
THE REAL CAUSE OF A
SICKNESS, THEY CAN TRY
TO FIND A CURE!

IS THERE A CURE FOR
WEIRD TEACHERS?



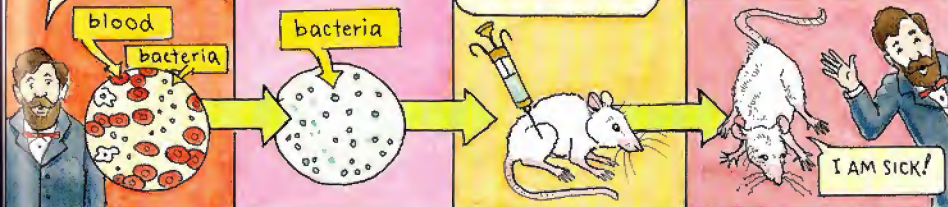
EXPERIMENT: PASTEUR INJECTED BACTERIA

I GOT BLOOD FROM
AN ANIMAL THAT
HAD ANTHRAX.

I TOOK OUT THE
BACTERIA.

I INJECTED THE
BACTERIA ONLY
INTO A HEALTHY
LAB ANIMAL.

THE ANIMAL GOT ANTHRAX!
THIS PROVED THAT THE
BACTERIA CAUSED THE DISEASE.



Scientists build on
one another's work

PASTEUR



LEEUVENHOEK



HOKE



FLASH

We filed out of Pasteur's lab and onto the bus. Ms. Frizzle stepped on the gas, flicked on the brights, and — *FLASH!* — the bus went into action. When it stopped, we were still in Paris, but we were at another laboratory. It was twenty years later. "Now we'll meet Marie and Pierre Curie," said the Friz. "They are about to discover something exciting."

WHAT ARE RAYS?

by Florrie

Rays are thin lines of energy.

There are:



light rays,



heat rays,

Xrays

and lots of others.

WE'LL WEAR THESE SUITS TO PROTECT US FROM THE DANGEROUS RAYS IN THE Curies' LAB.

DANGEROUS?

LET'S GO BACK TO THE GUY WHO SCRAPED THE GUNK OFF HIS TEETH!

The lab turned out to be a wooden shed.
Marie Curie was stirring a big pot over a fire.
The stirrer was almost as big as she was!
“What’s in the pot?” we wondered.



A STORY ABOUT MARIE CURIE

How She Got to Paris

Marie Curie was a famous scientist who worked in Paris, France. She came there from Poland, and her original name was Marya Skłodowska. Marya loved to learn. But at that time in Poland, girls were not allowed to go to college.



She worked for six years and saved enough money to go to the University of Paris. She was still so poor that she lived in an attic and ate almost nothing but tea and bread.



Marya changed her name to a French name, Marie. Later, when she married Pierre Curie, she changed her last name, too.

WHAT MAKES SOME MATERIALS GIVE OFF RAYS?

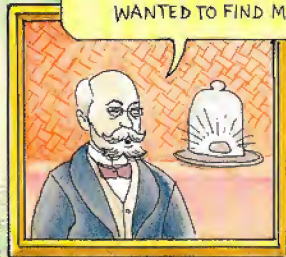
WHAT IS RADIOACTIVITY?

by Amanda Jane

Some materials are radioactive.
That means they give off
invisible rays.

When Marie Curie started her work, no one knew what the rays were made of.

I AM ANTOINE HENRI BECQUEREL. IN 1896, I FOUND URANIUM IN PITCHBLLENDE. IT WAS THE FIRST RADIOACTIVE ELEMENT TO BE DISCOVERED. MARIE CURIE WANTED TO FIND MORE.



Wanda looked in the pot. "It's just mud," she said. "This stuff is called pitchblende," said Marie. "I am trying to find a radioactive material in it."

I DON'T REALLY
UNDERSTAND
RADIOACTIVITY.

JUST WAIT AND
WE'LL LEARN ALL
ABOUT IT!

WE ALWAYS DO
IN MS. FRIZZLE'S
CLASS.

Marie's husband, Pierre, was a scientist, too. He became so interested in Marie's research that he gave up his own work and started helping her. Marie and Pierre Curie found a way to take the radioactive matter out of the pitchblende.

WE FOUND AN ELEMENT THAT WAS A MILLION TIMES MORE RADIOACTIVE THAN URANIUM.

I NAMED IT RADIUM.

IF I FOUND A NEW ELEMENT, I'D NAME IT JIM.

PIERRE CURIE
Born 1859 - Died 1906

WHAT THE Curies DID

by Phoebe

1. Shaveled pitchblende.
2. Boiled the pitchblende and let it cool.
3. Skimmed crystals off the top.
4. Tested them for radioactivity.
5. Saved only the radioactive crystals.
6. Started all over again.

AGAIN?

... AND OVER AND OVER AND OVER AGAIN!

IT TOOK THREE YEARS

The Curies had to work long and hard.



They used seven tons of pitchblende.



They were able to get only $\frac{1}{10}$ gram of radium.



$\frac{1}{10}$ gram radium

Even a paper clip weighs more than that.



$\frac{3}{10}$ gram

WHAT ARE ATOMS?

by John

Atoms are tiny, tiny bits.
They are too small to
see even with a microscope.
Everything is made of atoms,
even people.

MY ATOMS
JUST LOVE
HELIUM ATOMS.

HELIUM
BALLOON

HOW WE USE RADIOACTIVE MATERIALS

by Amanda Jane

Radium gives off some of its
energy as heat. Pierre Curie
found that he could use this
heat to make water boil.
There are many other uses
for radioactivity.

SOME USES ARE
HELPFUL TO PEOPLE.

OTHERS ARE
HARMFUL.

NUCLEAR
MEDICINE

NUCLEAR
WEAPONS

They found just a little bit of radium,
but it helped Marie make a big discovery.
"Marie realized that radioactivity must come
from inside the radium," said Pierre.
"Radium must be spitting out super-tiny
parts of its atoms," said Marie.
"When the atomic particles come out,
energy comes out, too."

A SIMPLE ATOM:
HELIUM ATOM



NUCLEUS
(CENTER)

THERE'S ENERGY
IN ATOMS!

IT'S ATOMIC
ENERGY!

RADIUM GIVES OFF
HEAT ENERGY AND
LIGHT ENERGY.

WE LOVE TO VISIT
THE LAB AT NIGHT.

IT GIVES OFF A
BEAUTIFUL
BLUE LIGHT.

PIERRE'S EXPERIMENT

A bit of radium
in a beaker of
water will make
the water boil.

A MORE COMPLEX ATOM:
RADIUM



RADIOACTIVITY:
nucleus of radium atom
spits out pieces

Today we know that too much radioactivity is harmful. But the Curies didn't know that. Dorothy Ann read from her book: "They didn't protect themselves. After a while, they became very sick."

OUR SUITS ARE
PROTECTING US.

I WISH WE COULD
WARN THE Curies.

BUT MS. FRIZZLE TOLD US
THERE IS NO WAY TO
CHANGE THE PAST.

CLASS, LET'S THANK
THE Curies AND
BE ON OUR WAY.

DANGEROUS NOTEBOOKS
by Tim

Even today, the Curies' notebooks are so radioactive that they are kept in radiation-proof containers.



HOW SCIENTISTS WORK
by Arnold

They put in long hours.
(The Curies worked night and day for years to discover radium.)

Sometimes scientists take risks, whether they mean to or not.
(The Curies did not know their work was dangerous.)



A STORY ABOUT ALBERT EINSTEIN

A Compass to Play With

One day, when Albert was about five years old, he was sick in bed. His father gave him a compass to play with.



Albert moved the compass all around, but the needle always kept pointing north. He realized that an invisible force was acting on the needle.



Einstein's life's work was to find out about the hidden forces of the universe.

We waved good-bye and went outside. A passenger was sitting quietly at the very back of the cardboard bus. It was Albert Einstein, the most famous scientist ever!



Then Ms. Frizzle flashed the lights, and the bus took off! As we traveled, Einstein told us about his work. "Most people have heard of my famous mathematical formula, $E = mc^2$," he said. "But many don't know what it means."

$E = mc^2$ EXPLAINS THAT MATTER AND ENERGY ARE REALLY FORMS OF THE SAME THING.

"MATTER CAN CHANGE TO ENERGY, AND ENERGY CAN CHANGE TO MATTER."

THAT'S WHAT HAPPENED IN THE CURIES' LAB!

YES, RADIUM—WHICH IS MATTER—CHANGED INTO HEAT AND LIGHT—WHICH ARE ENERGY!

A LAST WORD FROM DOROTHY ANN

Matter is all of the stuff in the universe, such as plants, pencils, pennies, and cats.

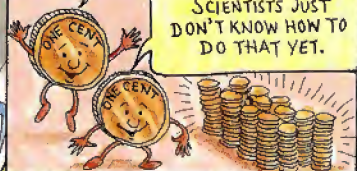
WHAT $E = mc^2$ DOES by Phil

- * It tells how the sun makes heat and light.
- * It explains radioactivity.
- * It tells how the universe began.

DID YOU KNOW?

IF THE MASS OF 100 PENNIES WERE CHANGED TO PURE ENERGY, IT COULD POWER NEW YORK STATE FOR TWO DAYS.

SCIENTISTS JUST DON'T KNOW HOW TO DO THAT YET.



The bus zoomed to the science museum,
bumped up the steps, rolled through the doors,
and stopped at Einstein's spot in the exhibit.
He stepped into place just in time.
No one had missed him yet.

Einstein said,
"The important thing is
never to stop questioning."

OUR CLASS WILL UNDERSTAND
YOUR IDEAS WHEN THEY ARE
OLDER, ALBERT.

MUCH OLDER!

TAKE YOUR TIME.
IT TOOK ME A WHILE TO
UNDERSTAND THEM MYSELF!

EVEN MS. FRIZZLE CAN'T
EXPLAIN EINSTEIN TO US.

EVEN EINSTEIN CAN'T
EXPLAIN YOUR BUS TO ME!

EINSTEIN'S IDEAS CHANGED HOW WE SEE THE UNIVERSE by Phoebe

Einstein had many amazing ideas
—not just $E=mc^2$.
Many of them seem impossible,
but they have been proved
by experiments and math.
His work inspired other scientists
to ask new questions.

What is SPACE-TIME?

What is RELATIVITY?
what is the
FABRIC of the UNIVERSE?

WHAT IS FOR LUNCH?

ALBERT
EINSTEIN
Born 1879
Died 1955



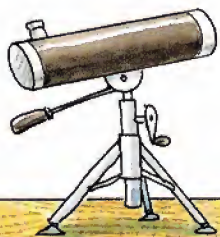
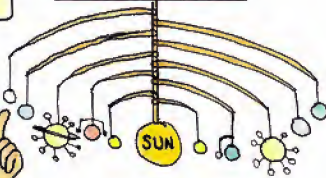
Then our teacher drove over to the photographer. Our picture was ready. It was amazing. Everyone was in it — even the scientists! It must have been magic.



OUR CLASS SCIENCE FAIR

NUMBER TEN?

SOLAR SYSTEM



How Many Planets Orbit Our Sun?
INSPIRED BY GALILEO and NEWTON
by Carlos

For years, we thought there were nine planets, including Pluto. But now scientists have found what might be a new planet far beyond the others.

Back at school, everyone got busy. We all had great questions to ask, such as: "How do you make a compass?" "How do plants get water?" and "What pattern will be on Ms. Frizzle's dress tomorrow?"

I KNEW VISITING THE SCIENTISTS WOULD INSPIRE US!



How Is Making Rock Candy Like Separating Radium From Pitchblende?

INSPIRED BY MARIE and PIERRE CURIE
by Keesha

Boil the sugar and water. Then let it cool. The sugar forms crystals, and that's rock candy.

(VERY HOT~ requires adult supervision!)



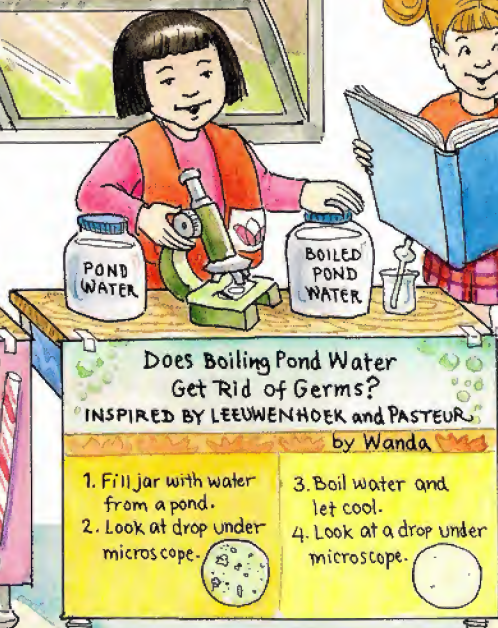
But the most important question
in Ms. Frizzle's class is always:
"Will we ever go on a normal school trip?"

SCIENCE
IS ABOUT ASKING QUESTIONS
AND TESTING IDEAS!

I FOUND MY ANTS!
NOW I CAN DO MY
PROJECT!

SCIENCE ISN'T JUST
ABOUT WHAT WE KNOW...

IT'S ABOUT WHAT WE
DON'T KNOW...YET.



Joanna and Bruce Visit

WE SCIENTISTS HAVE COMPLAINTS ABOUT YOUR BOOK.



COPERNICUS

A CLASS CAN'T REALLY GO BACK IN TIME.



LEEUWENHOEK

I DIDN'T REALLY SIT UNDER AN APPLE TREE. THAT'S JUST A STORY.



ISAAC NEWTON

I ASKED A LOT MORE QUESTIONS THAN THE ONES YOU SHOWED.



GALILEO GALILEI

I DISCOVERED HOW TO MAKE MILK SAFE TO DRINK. YOU LEFT THAT OUT, TOO.



LOUIS PASTEUR

PIERRE AND I FOUND THREE RADIOACTIVE ELEMENTS. YOU TOLD ABOUT ONLY ONE OF THEM.



PIERRE and MARIE CURIE

UH-OH! BRUCE, THE SCIENTISTS ARE COMPLAINING.



TELL THEM IT'S TOO LATE TO MAKE CHANGES, JOANNA.



the Gallery of Scientists

ALSO, MARIE CURIE ISN'T THE ONLY WOMAN SCIENTIST. THERE ARE THOUSANDS OF OTHERS.

GENETICS



BARBARA MCCLINTOCK

SO FAR, AT LEAST TWELVE NOBEL PRIZES HAVE BEEN AWARDED TO WOMEN IN SCIENCE.

RADIOACTIVITY



IRÈNE JOLIOT-CURIE

THE IMPORTANT THING IS THAT YOU TOLD US HOW SCIENTISTS THINK...

SPLITTING THE ATOM



LISE MEITNER

...AND HOW SCIENTISTS BUILD ON ONE ANOTHER'S IDEAS...

ELECTROMAGNETISM



MICHAEL FARADAY

...AND THAT SCIENCE IS ALWAYS OPEN TO NEW DISCOVERIES.

ORIGIN OF SPECIES



CHARLES DARWIN

YES, I THINK THEY DID A GOOD JOB.

PHYSICS



ALBERT EINSTEIN

THANK YOU.

WE TRIED.

IT WAS GREAT MEETING YOU.





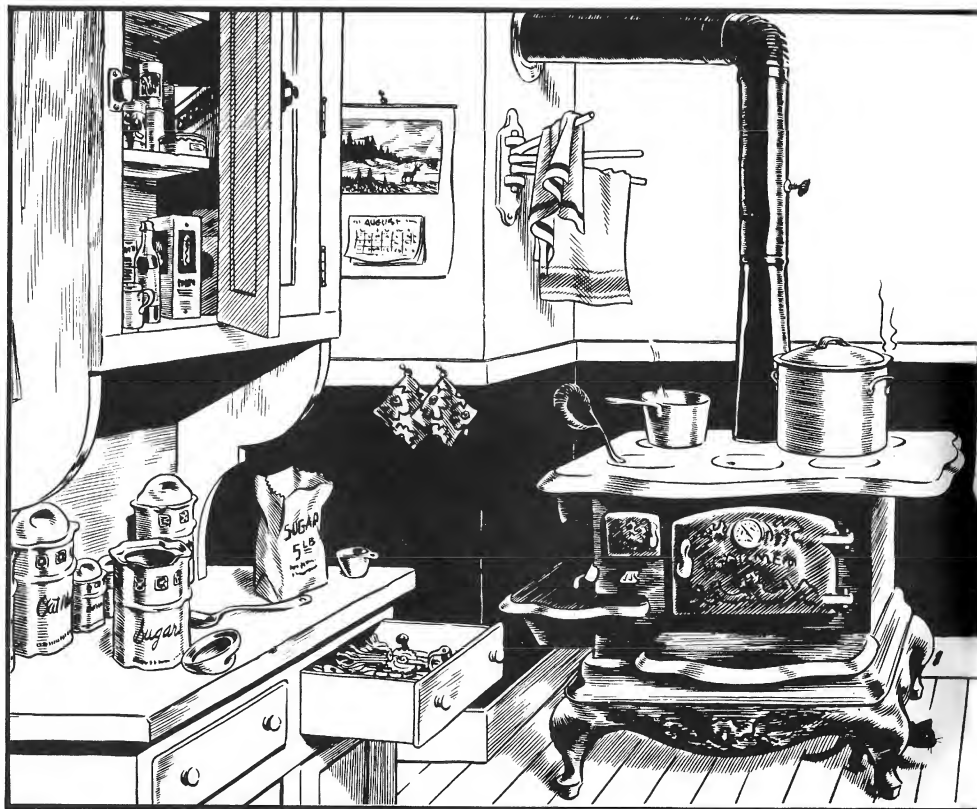






BLUEBERRIES FOR SAL

ROBERT McCLOSKEY





Blueberries for Sal

Also by Robert McCloskey

LENTIL

MAKE WAY FOR DUCKLINGS

HOMER PRICE

CENTERBURG TALES

ONE MORNING IN MAINE

TIME OF WONDER

BURT DOW: DEEP-WATER MAN

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08

Blueberries for Sal

ONE day, Little Sal went with her mother to Blueberry Hill to pick blueberries.

Little Sal brought along her small tin pail and her mother brought her large tin pail to put berries in. "We will take our berries home and can them," said her mother. "Then we will have food for the winter."





Little Sal picked three berries and dropped them in her
little tin pail . . . *kuplink, kuplank, kuplunk!*





She picked three more berries and ate them. Then she picked more berries and dropped one in the pail—*kuplunk!* And the rest she ate. Then Little Sal ate all four blueberries out of her pail!

Her mother walked slowly through the bushes, picking blueberries as she went and putting them in her pail. Little Sal struggled along behind, picking blueberries and eating every single one.





Little Sal hurried ahead and dropped a blueberry in her mother's pail. It didn't sound *kuplink!* because the bottom of the pail was already covered with berries. She reached down inside to get her berry back. Though she really didn't mean to, she pulled out a large handful, because there were so many blueberries right up close to the one she had put in.





Her mother stopped picking and said, "Now, Sal, you run along and pick your own berries. Mother wants to take her berries home and can them for next winter."

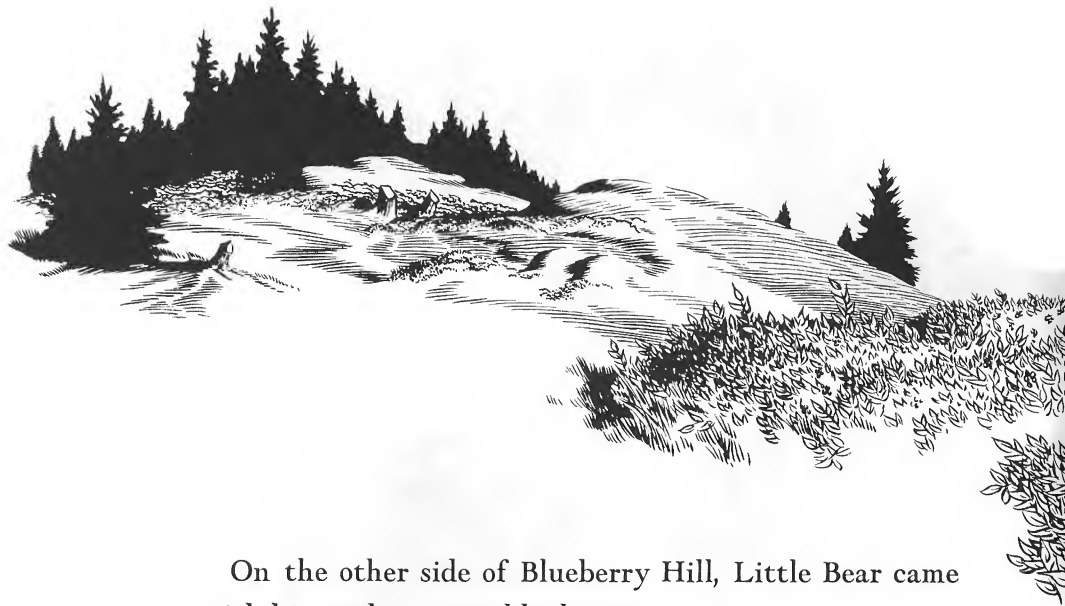




Her mother went back to her picking, but Little Sal, because her feet were tired of standing and walking, sat down in the middle of a large clump of bushes and ate blueberries.







On the other side of Blueberry Hill, Little Bear came with his mother to eat blueberries.

“Little Bear,” she said, “eat lots of berries and grow big and fat. We must store up food for the long, cold winter.”



Little Bear followed behind his mother as she walked slowly through the bushes eating berries. Little Bear stopped now and then to eat berries.





Then he had to hustle along to catch up!



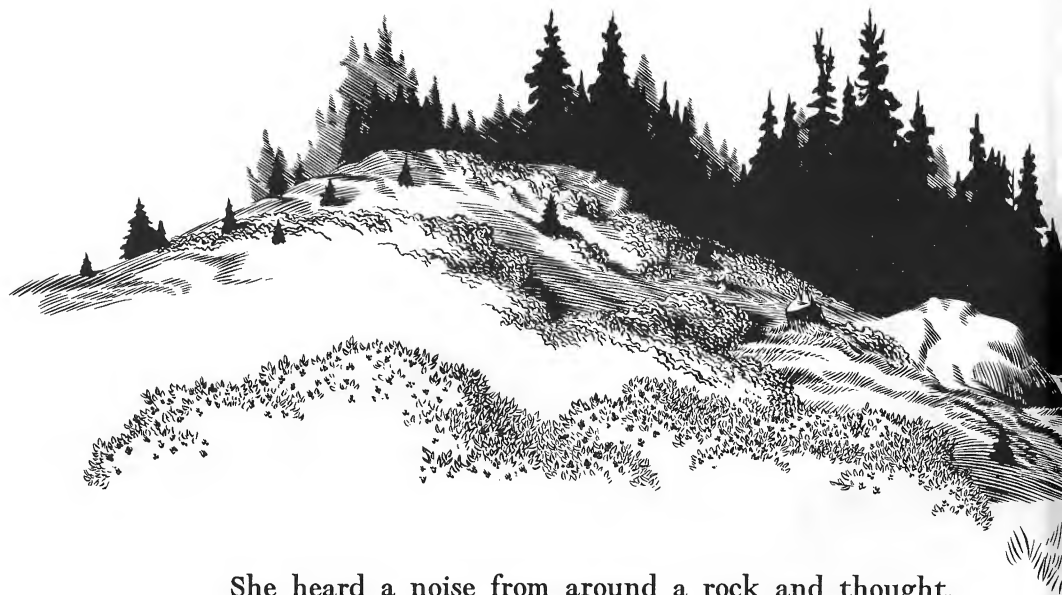
Because his feet were tired of hustling, he picked out a large clump of bushes and sat down right in the middle and ate blueberries.





Over on the other side of the hill, Little Sal ate all of the berries she could reach from where she was sitting, then she started out to find her mother.





She heard a noise from around a rock and thought,
“That is my mother walking along!”







But it was a mother crow and her children, and they stopped eating berries and flew away, saying, “Caw, Caw, Caw.” Then she heard another noise in the bushes and thought, “That is *surely* my mother and I will go that way.”

But it was Little Bear's mother instead. She was tramping along, eating berries, and thinking about storing up food for the winter. Little Sal tramped right along behind.





By this time, Little Bear had eaten all the berries he could reach without moving from his clump of bushes. Then he hustled off to catch up with his mother. He hunted and hunted but his mother was nowhere to be seen. He heard a noise from over a stump and thought, "That is my mother walking along."







But it was a mother partridge and her children. They stopped eating berries and hurried away. Then he heard a noise in the bushes and thought, "That is surely *my* mother. I will hustle that way!"





But it was Little Sal's mother instead! She was walking along, picking berries, and thinking about canning them for next winter. Little Bear hustled right along behind.



Little Bear and Little Sal's mother and Little Sal and Little Bear's mother were all mixed up with each other among the blueberries on Blueberry Hill.





Little Bear's mother heard Sal walking along behind and thought it was Little Bear and she said, "Little Bear," *munch, munch*, "Eat all you —" *gulp*, "can possibly hold!" *swallow*. Little Sal said nothing. She picked three berries and dropped them, *kuplink, kuplank, kuplunk*, in her small tin pail.





Little Bear's mother turned around to see what on earth could make a noise like *kuplunk!*

"*Garumpf!*" she cried, choking on a mouthful of berries, "This is not my child! Where is Little Bear?" She took one good look and backed away. (She was old enough to be shy of people, even a very small person like Little Sal.) Then she turned around and walked off very fast to hunt for Little Bear.





Little Sal's mother heard Little Bear tramping along behind and thought it was Little Sal. She kept right on picking and thinking about canning blueberries for next winter.





Little Bear padded up and peeked into her pail. Of course, he only wanted to taste a *few* of what was inside, but there were so many and they were so close together, that he tasted a Tremendous Mouthful by mistake. “Now, Sal,” said Little Sal’s mother without turning around, “you run along and pick your own berries. Mother wants to can these for next winter.” Little Bear tasted another Tremendous Mouthful, and almost spilled the entire pail of blueberries!





Little Sal's mother turned around and gasped, "My Goodness, *you* are not Little Sal! Where, oh where, is my child?"

Little Bear just sat munching and munching and swallowing and licking his lips.

Little Sal's mother slowly backed away. (She was old enough to be shy of bears, even very small bears like Little Bear.) Then she turned and walked away quickly to look for Little Sal.









She hadn't gone very far before she heard a *kuplink!*
kuplank! kuplunk!

She knew just what made that kind of a noise!



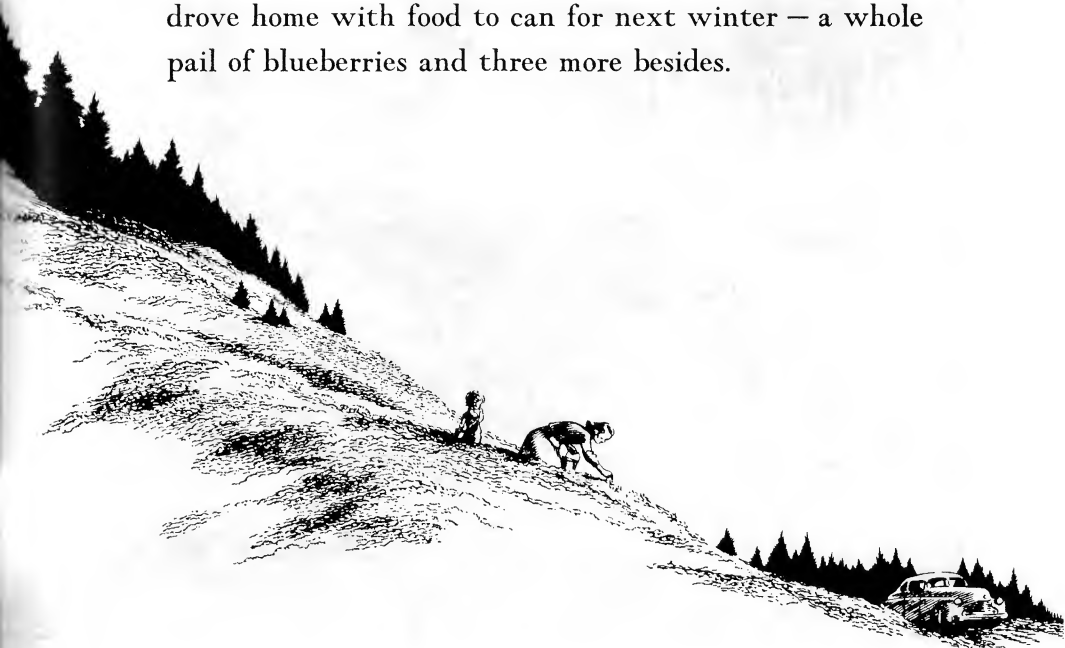
Little Bear's mother had not hunted very long before she heard a hustling sound that stopped now and then to munch and swallow. She knew just what made that kind of a noise.

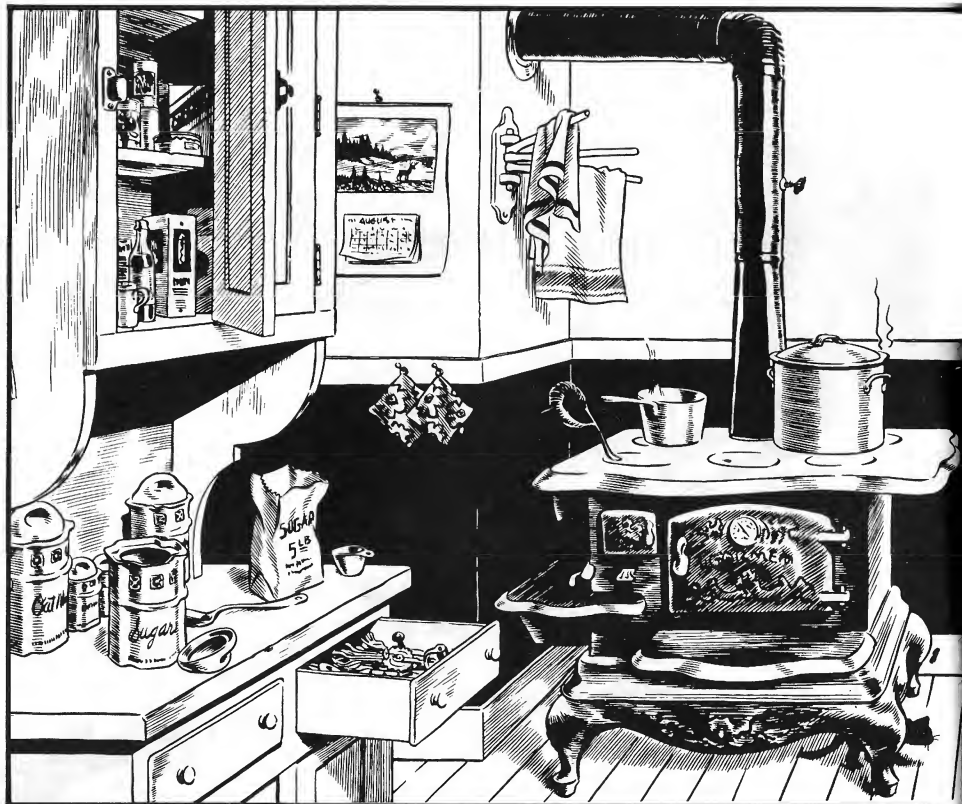




Little Bear and his mother went home down one side of Blueberry Hill, eating blueberries all the way, and full of food stored up for next winter.

And Little Sal and her mother went down the other side of Blueberry Hill, picking berries all the way, and drove home with food to can for next winter — a whole pail of blueberries and three more besides.

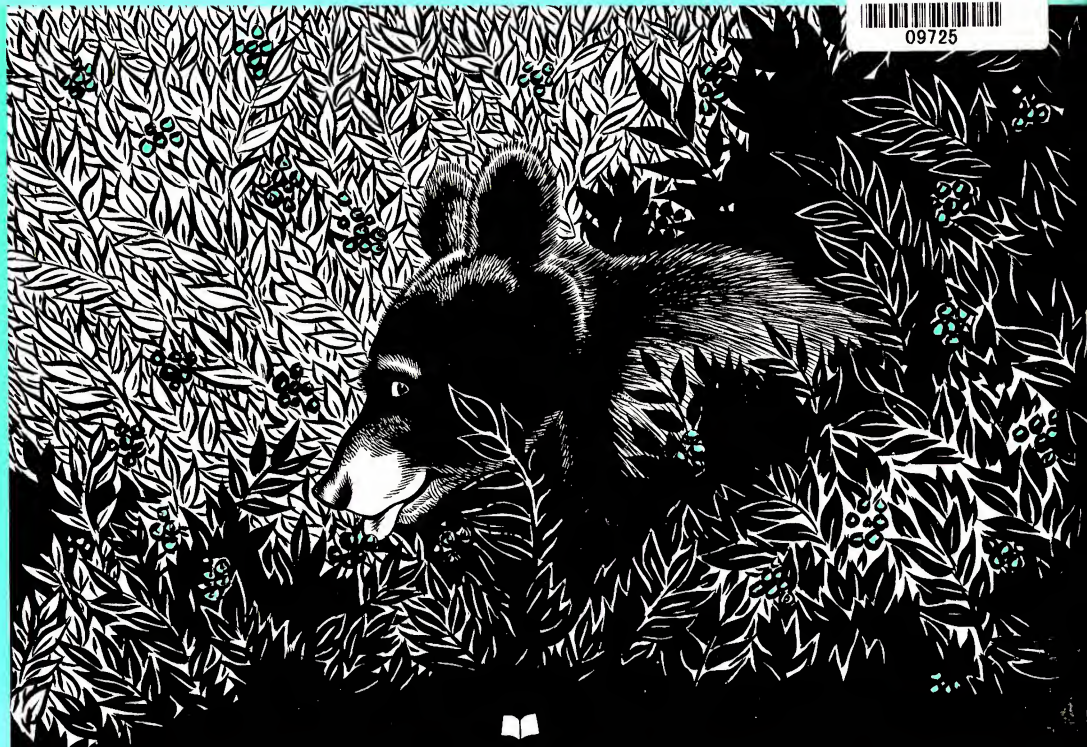








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